14352

WARNING: You must return this section with your answer book otherwise marks will be lost.

Write Your Examination Number here

AN ROINN OIDEACHAIS AGUS EOLAÍOCHTA

LEAVING CERTIFICATE EXAMINATION, 1998

PHYSICS — HIGHER LEVEL

THURSDAY, 18 JUNE — AFTERNOON 2.00 to 5.00

Answer **all** questions in Section A.

Answer **two** questions from Section B and **three** questions from Section C.

SECTION A (120 marks)

Answer each question in this section.
Each question carries the same number of marks.
Write your answers in the spaces provided.
Write your examination number at the top.
Be sure to return this section of the examination paper, enclosing it in the answer book you use in answering Sections B and C.

1. Answer *five* of the following items, (i), (ii), (iii), etc. In the case of each item write the letter corresponding to the correct answer in the box provided.

(i) The unit of pressure, the pascal, is equivalent to

A. kg m^2 s^{-1}
B. kg m^1 s^{-2}
C. kg m^{-2}
D. kg m^{-1} s^{-2}
E. kg m^{-2} s^{-1}.

Answer ☐ (6)

(ii) A horizontal force of 18 N is applied to a block of mass 4.0 kg so that it moves at a constant speed over a horizontal surface. Taking the value of *g* to be 9.8 m s^{-2}, the coefficient of dynamic friction between the block and the surface is

A. 4.5
B. 2.2
C. 0.46
D. 0.22
E. 0.02.

Answer ☐ (6)

(iii) When the intensity of a sound increases from 12 mW m^{-2} to 18 mW m^{-2} the relative increase in intensity, in decibels, is

A. 0.18
B. 1.8
C. 6.0
D. 7.8
E. 15.

Answer ☐ (6)

(iv) A line spectrum is obtained from a certain light source. Which of the following statements is *not* correct?

A. The positions of the lines depend on the frequency of the light.
B. The number of lines depends on the energy levels of the atoms of the source.
C. The colours of the lines depend on the speed of the light.
D. The colours of the lines depend on the wavelength of the light.
E. The positions of the lines depend on the energy levels of the atoms of the source. Answer ☐ (6)

(v) The e.m.f. of a simple cell depends on

A. the material of the electrodes
B. the current being drawn from the cell
C. the internal resistance of the cell
D. the mass of the electrodes
E. the volume of the electrolyte. Answer ☐ (6)

(vi) In a nuclear reactor the purpose of the moderator is to reduce

A. the temperature of the reactor
B. the number of neutrons causing fission
C. the rate at which energy is released
D. the speed of the neutrons
E. the supply of U-235. Answer ☐ (6)

2. Answer *five* of the following.

(i) When a particle is undergoing simple harmonic motion its ....is a maximum

when its ....is a maximum. (6)

(ii) Power is defined as ....

and it is measured in .... (6)

(iii) In a compound microscope the object is positioned just ....of the objective lens

and the image produced by the objective lens is located ....of the eyepiece lens. (6)

(iv) The magnetic effect of a current was discovered by the Danish scientist ....

at the beginning of the .... century. (6)

(v) The resistivity of a metal is defined as ....

.... (6)

(vi) X-rays are produced when high speed ....strike a metal

which has a high.. (6)

3. Answer *five* of the following.

(i) Give two properties of the electron. ....

.... (6)

(ii) What is the kinetic energy, in joules, of an electron which has been accelerated from rest through a potential difference of 2000 V (charge on electron, $e = 1.6 \times 10^{-19}$ C)? ....

.... (6)

(iii) When a current flows through a gas the charge carriers are electrons and .... (6)

(iv) When electrons are emitted from a hot metal surface the process is known as..

.... (6)

(v) What is the purpose of the grid in a cathode ray tube?...

.... (6)

(vi) Electrons emitted from radioactive nuclei are normally known as .... (6)

4. Answer *five* of the following.

(i) Define capacitance ....(6)

(ii) The unit of capacitance is the ...., which is equivalent to

.... per volt. (6)

(iii) Give an equation for the capacitance of a parallel plate capacitor .... (6)

(iv) A capacitor of capacitance 100 μF is charged to a potential of 12 V. What is the energy stored in the capacitor? .... (6)

(v) A capacitor connected in series in a circuit ....a.c. whereas it .... d.c. (6)

(vi) What is the function of the capacitor in Fig 1? .... (6)

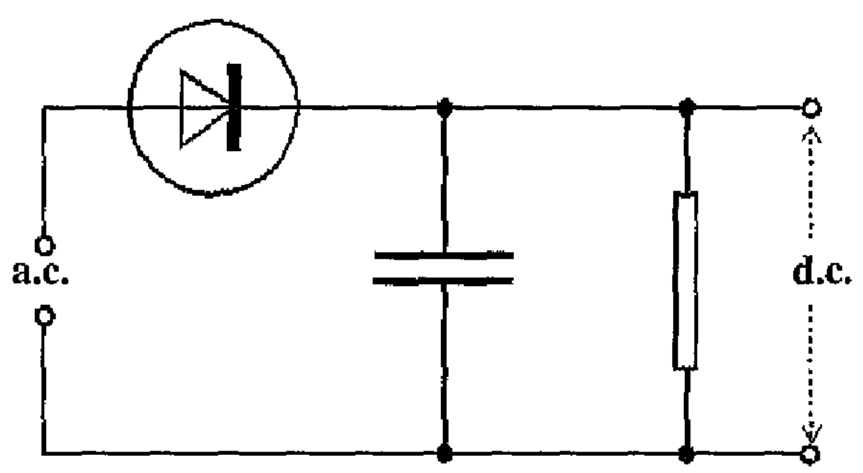

Fig. 1

AN ROINN OIDEACHAIS AGUS EOLAÍOCHTA

LEAVING CERTIFICATE EXAMINATION, 1998

PHYSICS — HIGHER LEVEL

Section A is on a separate sheet which provides spaces for your answers. The completed sheet should be enclosed in your answer book.

Write your answers to Sections B and C in your answer book.

SECTION B (80 marks)

Answer **two** of the questions from this section.

Each question carries the same number of marks.

5. In an experiment to verify the principle of moments a number of forces were applied to a metre stick as shown in Fig. 2. The metre stick was horizontal and in equilibrium when the forces were applied at the positions shown in the diagram. The centre of gravity was found to be at the 50 cm mark.

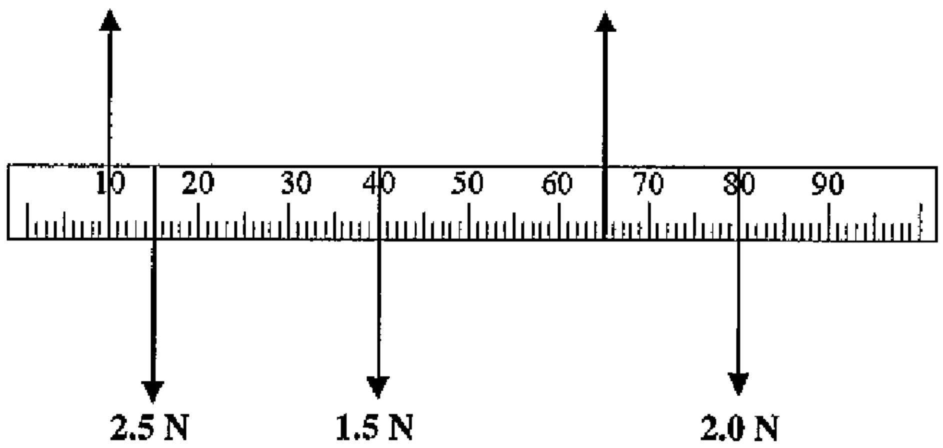

Fig. 2

Using the data given on the diagram calculate the weight of the metre stick.

Explain how the arrangement shown in Fig. 2 verifies the principle of moments.

Give one precaution which should be taken when carrying out this experiment. (21)

Explain:

(i) how the upward forces might have been applied and measured in this experiment;

(ii) how the centre of gravity of the metre stick might have been found. (12)

If the metre stick had not been horizontal how could this arrangement have been used to verify the principle of moments? (6)

6. The following is part of a student's account of an experiment to investigate the relationship between the natural frequency of a stretched string and its length.

"A constant force was applied to the end of the wire and the length of the wire was adjusted. When the wire was resonating the frequency and length were recorded. This procedure was repeated several times. The values obtained for the frequency, *f*, and the length, *l*, are shown in the table."

f/Hz	256	288	320	341	384	427	480	512
l/cm	51.3	42.6	39.2	37.7	34.5	30.3	26.0	25.0

Draw a suitable graph on graph paper to illustrate the relationship between the natural frequency of the wire and its length. State the relationship and explain how the graph verifies it. (18)

Draw a labelled diagram of the apparatus which might have been used in this experiment. Indicate on the diagram the points between which the length of the wire would have been measured. (9)

Why was it necessary to keep the force applied to the end of the wire constant? (6)

How might the student have determined that the wire was resonating? (6)

7. In an experiment to determine the electrochemical equivalent of copper a student passed a current of 0.4 A through a copper sulphate solution for 20 minutes The mass of copper liberated from the solution in this time was found to be 0.16 g.

Calculate the value for the electrochemical equivalent of copper which would have been obtained by the student. (12)

Draw a circuit diagram for this experiment, labelling the anode and cathode. (9)

Give the steps involved in finding the mass of copper liberated. (9)

Using too large a current might have introduced an error into the value obtained for the mass of copper liberated. Explain. (9)

SECTION C (200 marks)

Answer **three** questions from this section.

Each question carries the same number of marks.

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8. (i) What conclusion can be drawn from the equation $E = mc^2$ concerning the nature of mass? (6)

(ii) Give an expression for Newton's Universal Law of Gravitation. (6)

Describe a laboratory experiment to determine the value of g, the acceleration due to gravity. (18)

The sun emits energy in the form of electromagnetic radiation at a rate of 3.9×10^{26} J s^{-1}. Calculate the decrease in the sun's mass in 1.7×10^8 years as a result of this emission of energy. (9)

A satellite is in a circular orbit of radius r around a body of mass M, Fig. 3. Show that the period of the satellite is given by $T^2 = \frac{4\pi^2 r^3}{GM}$. (12)

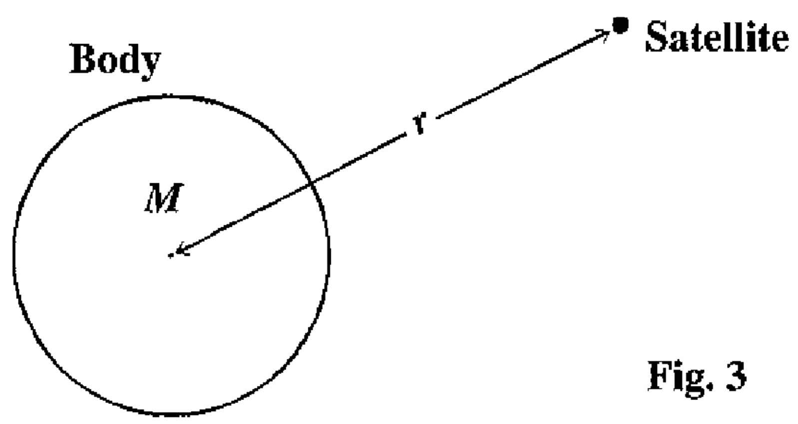

Fig. 3

The planet Jupiter is a satellite of the sun and the radius of its orbit around the sun is 7.8×10^{11} m. Given that the mass of the sun is 2.0×10^{30} kg calculate the time taken for Jupiter to make one complete orbit of the sun. (15)

(Speed of light in vacuum, $c = 3.0 \times 10^8$ m s^{-1}; 1 year = 3.2×10^7 s; $G = 6.7 \times 10^{-11}$ N m^2 kg^{-2}.)

9. Define (i) specific heat capacity, (ii) specific latent heat. (12)

Describe an experiment to measure the specific heat capacity of a liquid *or* a solid. (18)

A saucepan containing water is left boiling on a cooker in a kitchen for some time. As the water evaporates from the saucepan and then condenses the temperature of the air in the kitchen is raised.

Explain how this process of evaporation and condensation raises the temperature of the air in the kitchen and give another method by which energy is transferred from the saucepan of water to the air. (15)

Given that the volume of the air in the kitchen is 15.6 m^3 and that water is evaporating from the saucepan at a rate of 0.65 g per second calculate:

(i) the rate at which energy is transferred from the water in the saucepan by evaporation;

(ii) the rise in temperature of the air caused by the evaporation and condensation in 5 minutes, assuming that 10% of the transferred energy is absorbed by the air.
(Specific heat capacity of air = 1.0×10^3 J kg^{-1} K^{-1}; specific latent heat of vaporisation of water = 2.3×10^6 J kg^{-1}; density of air = 1.2 kg m^{-3}.) (21)

10. (*a*) State briefly how it may be shown experimentally that light may be polarised. (9)

The experiment illustrated in Fig. 4 is a version of an experiment which was first carried out at the beginning of the nineteenth century. Light from a light source L is passed through a single slit S, then through O, and finally onto a screen.

(i) Comment on the historical significance of this experiment and name the scientist who first carried it out. (6)

(ii) What is the part of the apparatus labelled O and what is its function in this experiment? (9)

(iii) State what is observed on the screen and say how the observation is explained. (9)

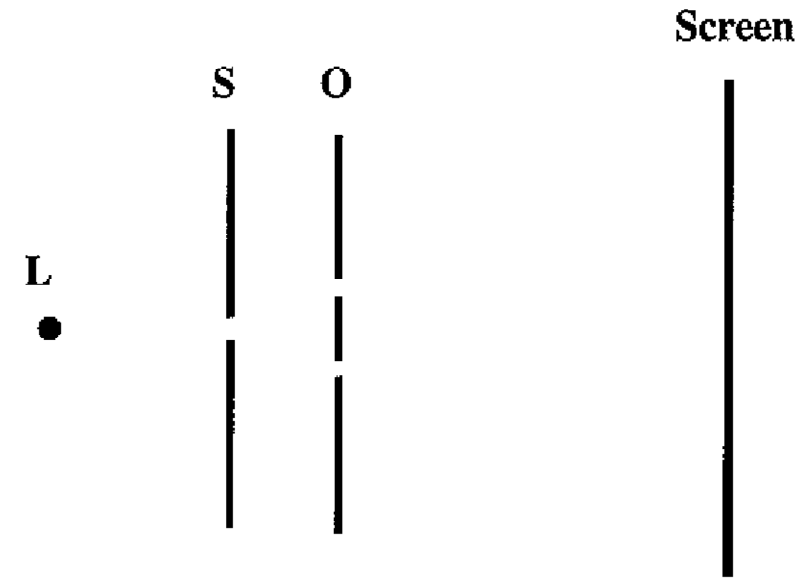

Fig. 4

(*b*) How may it be shown experimentally that sound is a wave motion? (9)

A train's whistle emits a continuous note of frequency 640 Hz as it approaches a person standing near the track. To the person the frequency of the note appears to be 720 Hz.

(i) Explain, with the aid of a diagram, why the frequency of the note appears higher to the person standing near the track. (12)

(ii) Calculate the speed of the train.

(Speed of sound in air = 340 m s^{-1}.) (12)

11. State Faraday's law of electromagnetic induction. (6)

Describe an experiment to illustrate this law. (12)

Draw a labelled diagram of an a.c generator and explain how it works. (21)

Explain the principles involved in each of the following.

(i) A coil with an iron core has a higher effective resistance to a.c. than it does to d.c. (9)

(ii) A galvanometer coil is wound on an aluminium former to slow the motion of the coil. (9)

(iii) A transformer is made more efficient by laminating the core. (9)

12. What is meant by the term semiconductor? (6)

Sketch a graph to show how the resistance of a semiconductor changes with temperature and explain why this change occurs. (15)

Fig. 5 shows a temperature controlled switch. Explain why the lamp, L, lights when the thermistor, T, is heated. (15)

Explain how the resistance of the resistor R affects the operation of this circuit. (9)

For the transistor shown in Fig. 5 the collector current is found to be 200 times the base current. When the thermistor is at a certain temperature the potential difference across the thermistor is 0.8 V and the potential difference between the base and emitter of the transistor is 0.6 V. Calculate:

(i) the potential difference across R;

(ii) the base current;

(iii) the emitter current. (21)

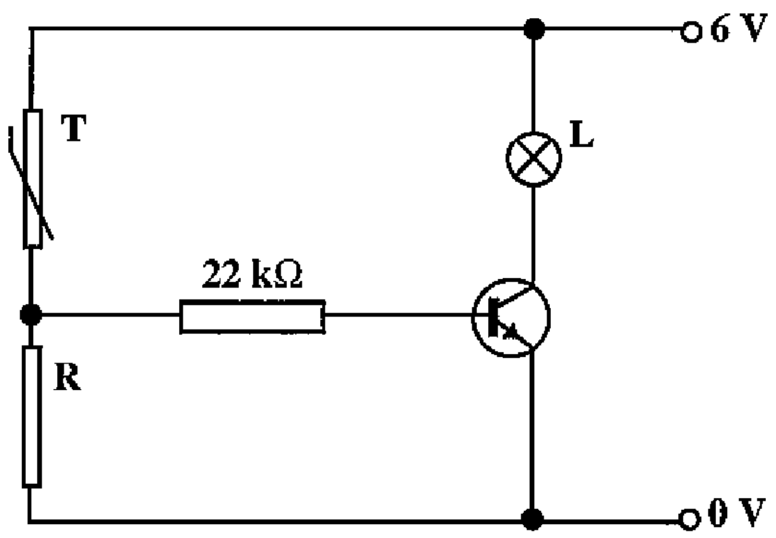

Fig. 5

13. Answer any *two* of the following.

(*a*) State the principle of conservation of momentum and describe an experiment to verify it. (21)

The direction in which a spacecraft is travelling can be changed by expelling a small mass of gas from it.

A spacecraft travelling with a certain velociy in the direction OA (Fig. 6) expels a mass of gas in the direction OB. Copy the diagram and show on it a possible direction for the new velocity of the spacecraft and explain why expelling the gas changes the velocity of the spacecraft. (12)

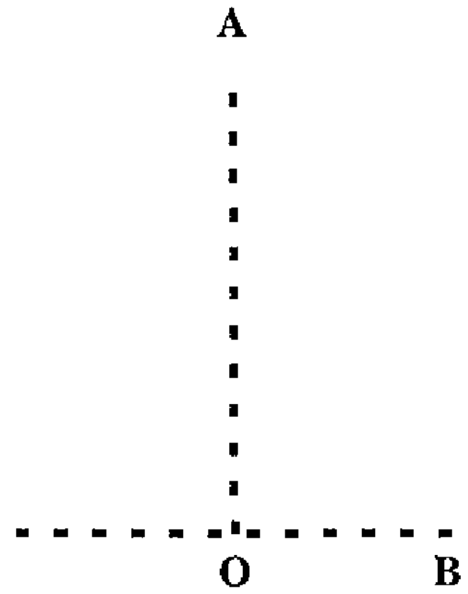

Fig. 6

(*b*) Explain the terms (i) ideal gas, (ii) root-mean-square speed. (12)

How is temperature defined on the ideal gas scale? (6)

Use the kinetic theory equation, $p = \frac{1}{3}\frac{Nm\overline{c^2}}{V}$, to show that the temperature of a gas on the ideal gas scale is proportional to the average kinetic energy of its molecules. (15)

(*c*) Dispersion and total internal reflection are two phenomena which may occur when light is passed into a prism. Define the underlined terms. (12)

Explain why dispersion may occur when light is passed into a prism. (6)

Use a diagram to show how a prism may be used to reflect light through an angle of 90°. Calculate the minimum value of the refractive index of the material of the prism for this to occur. (15)

(*d*) State the law of radioactive decay. (6)

Describe an experiment to measure the half-life of a short-lived radioactive isotope. (15)

A sample of a certain substance contains 2.5×10^{21} radioactive nuclei. If the nuclei are decaying at a rate of 3.4×10^{10} per second calculate the half-life of the substance. (12)